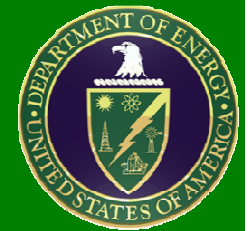


# “Appendix”: More CEUS / Result Background



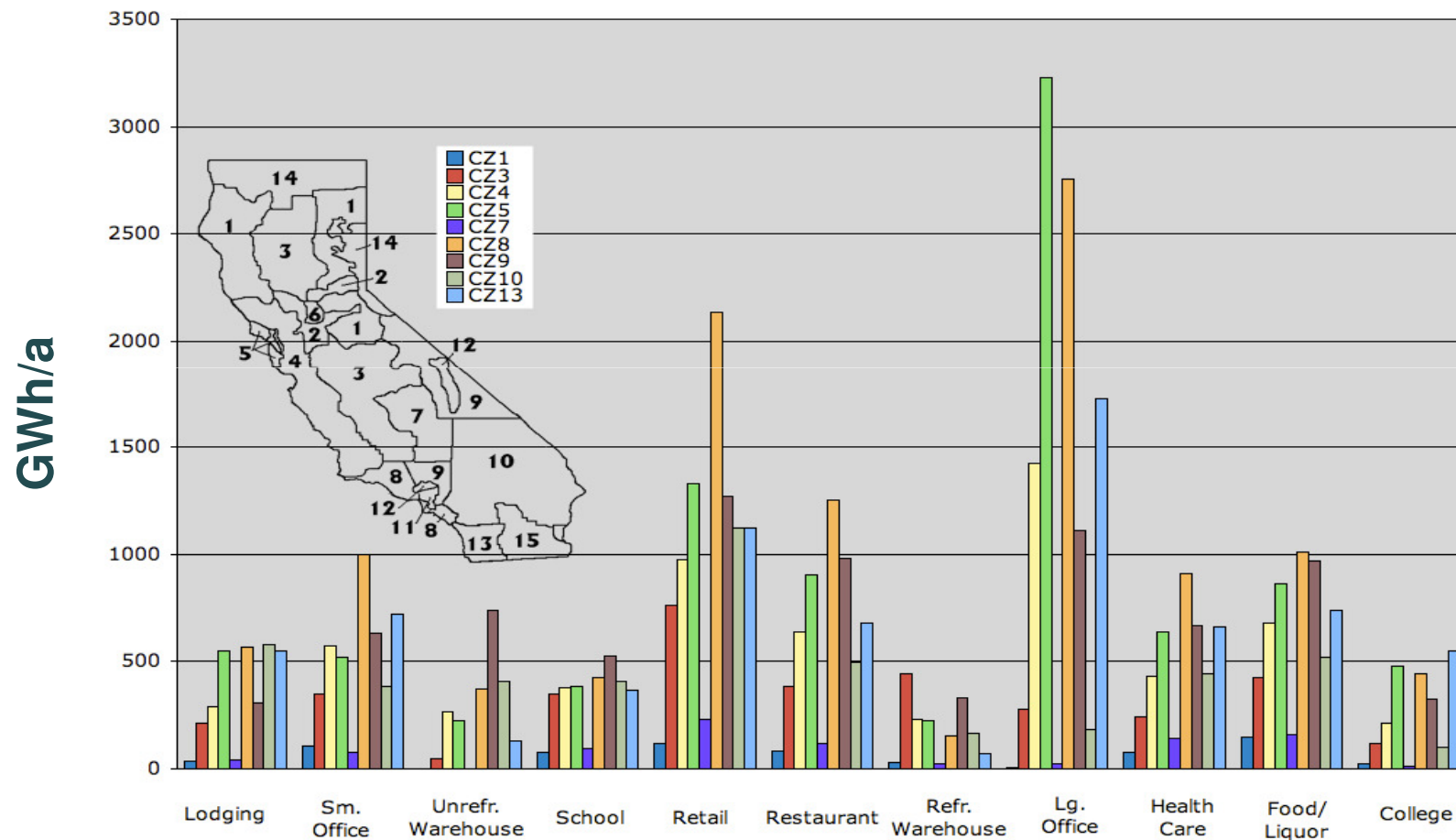
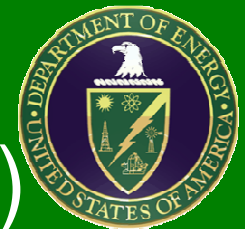
# End-Uses in CEUS



- 3 HVAC End Uses
  - Space Heating
  - Space Cooling
  - Ventilation
  
- 10 Non-HVAC End Uses
  - Water Heating
  - Cooking
  - Refrigeration
  - Interior Lighting
  - Exterior Lighting
  - Office Equipment
  - Miscellaneous Equipment
  - Air Compressors
  - Motors (non-HVAC)
  - Process Equipment

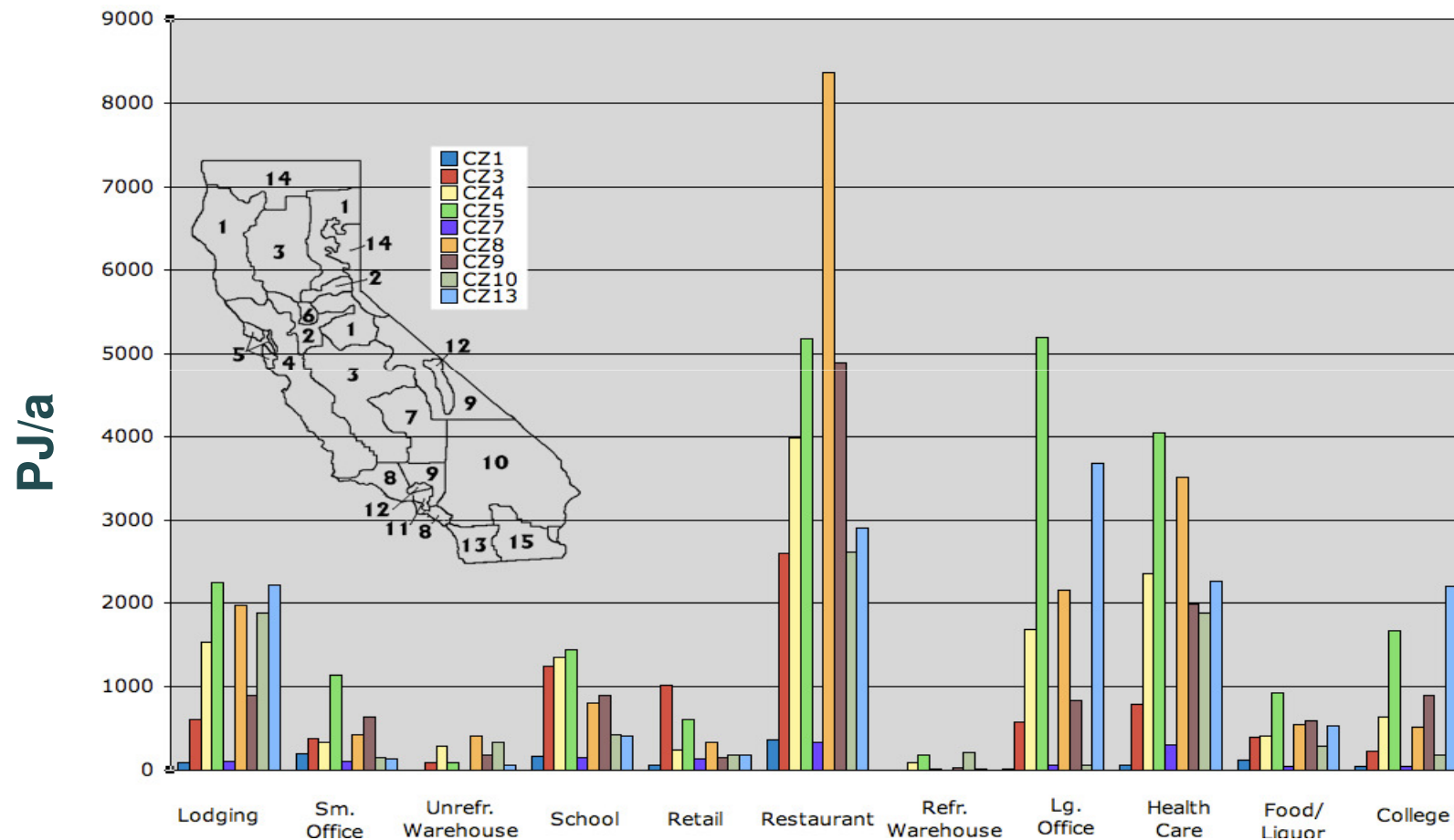
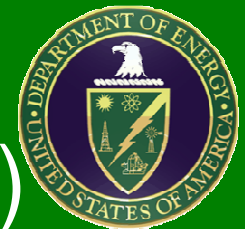


# Annual Electricity Use by Building Types and Zones (CEUS)



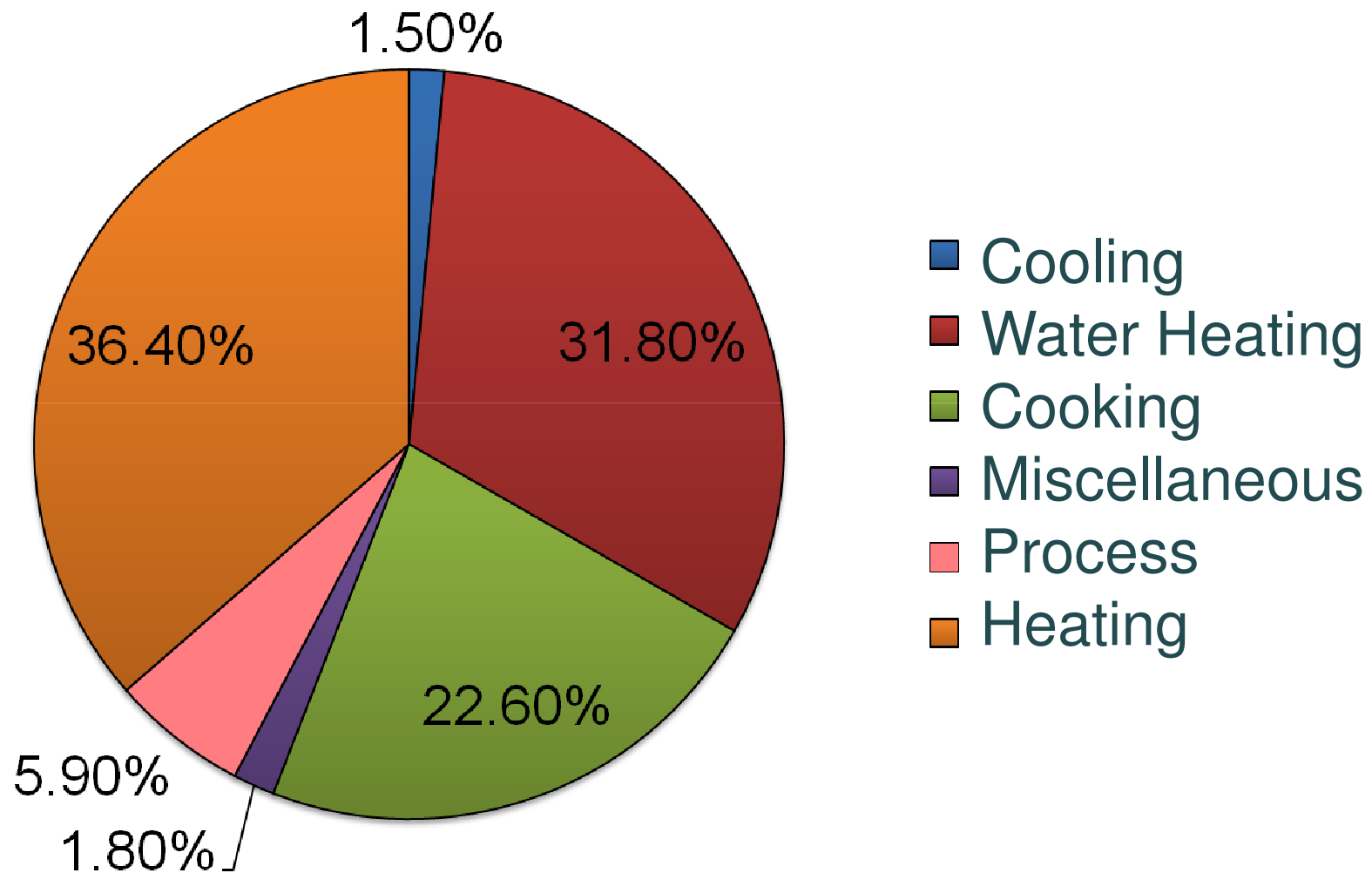


# Annual Natural Gas Use by Building Types and Zones (CEUS)



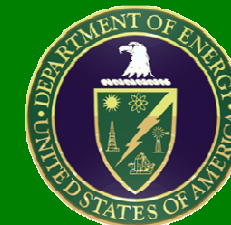


# NG by End Use in CEUS





# Considered Bldg. Types



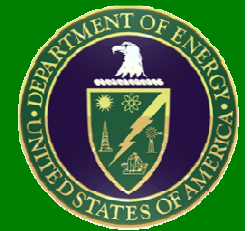
	Small Office			Large Office			Restaurant			Retail Store			Food/Liquor			Un. Warehouse		
TOTAL	1			25			1			9			9			7		
Zone	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L
FCZ 01				★	★							★			★			
FCZ 03				★	★	★						★			★			★
FCZ 04			★	★	★	★			★			★			★			★
FCZ 05				★	★	★						★			★			★
FCZ 07				★	★	★						★			★			
FCZ 08				★	★	★						★			★			★
FCZ 09				★	★							★			★			★
FCZ 10				★	★	★						★			★			★
FCZ 13				★	★	★						★			★			★

optimizations  
take up to 10  
hours

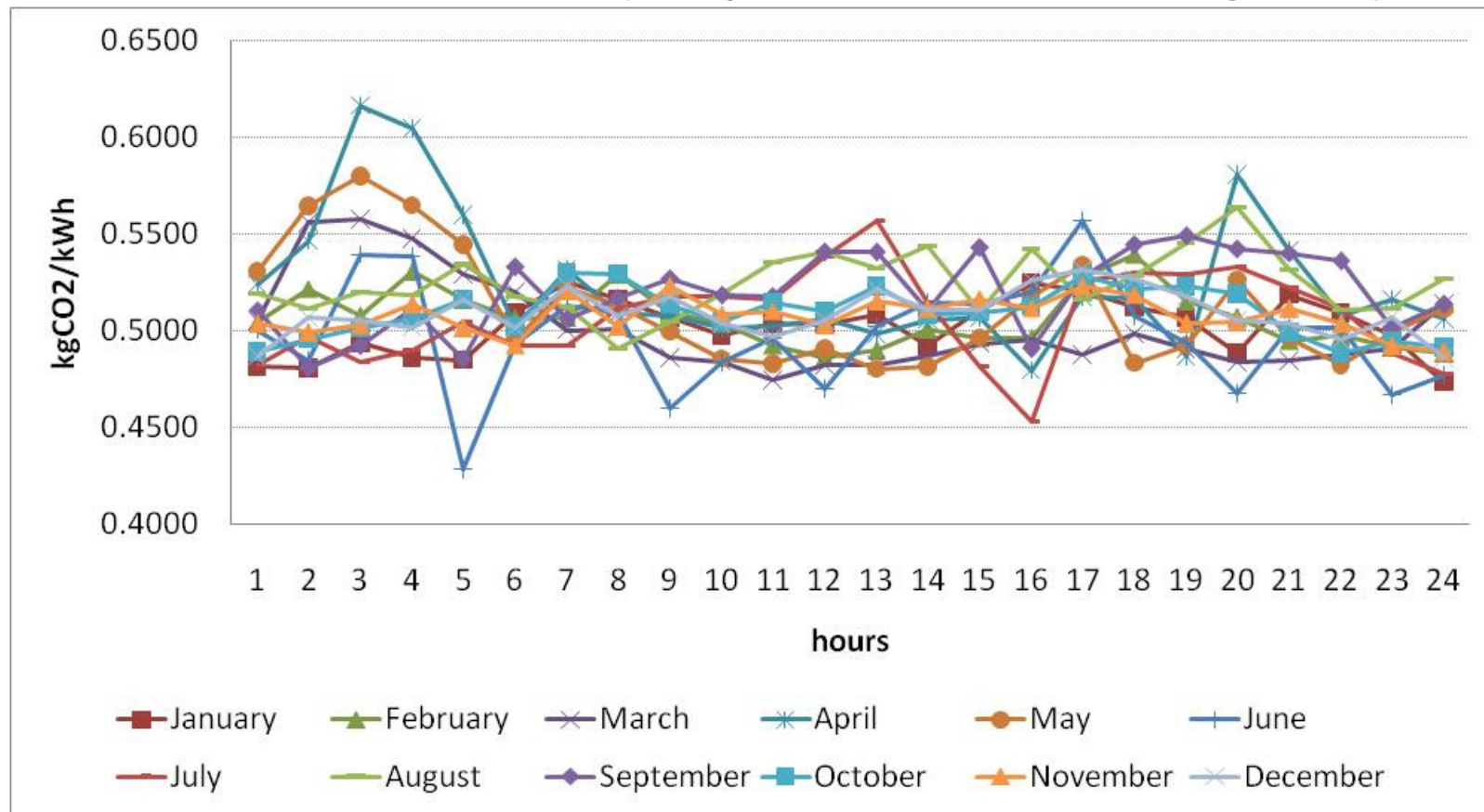
	School			College			Health Care			Hotel			Misc			Ref. Warehouse			
TOTAL	18			18			17			16			0			17			
Zone	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	TOTAL
FCZ 01		★	★		★	★		★	★			★					★		12
FCZ 03		★	★		★	★		★	★		★	★					★	★	16
FCZ 04		★	★		★	★		★	★		★	★					★	★	18
FCZ 05		★	★		★	★			★		★	★					★	★	15
FCZ 07		★	★		★	★		★	★			★					★	★	14
FCZ 08		★	★		★	★		★	★		★	★					★	★	16
FCZ 09		★	★		★	★		★	★		★	★					★	★	15
FCZ 10		★	★		★	★		★	★		★	★					★	★	16
FCZ 13		★	★		★	★		★	★		★	★					★	★	16
TOTAL																			138



# Marginal Macrogrid CO<sub>2</sub> Emission Rates in 2020



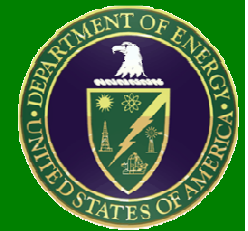
used for the whole state (except **run M-hc**, see following slides)



source: Developing a Greenhouse Gas Tool for Buildings in California: Methodology and Use, Amber Mahone, Snuller Price, William Morrow, Energy and Environmental Economics, Inc., September 10, 2008 and PLEXOS Production Simulation Dispatch Model.



# Tariffs



## ● PGE

- electric peak load 0 – 199 kW: flat tariff A-1, no demand charge, seasonal difference between winter and summer months of a factor of 1.45
- electric peak load 200 kW – 499 kW: TOU tariff A-10, seasonal demand charge
- Electric peak load 500 kW and above: TOU tariff E-19, seasonal demand charge

## ● SCE

- electric peak load 20 – 200 kW: flat tariff GS-2, no demand charge, seasonal difference between winter and summer months of a factor of 1.1
- electric peak load 200 kW – 500 kW: tariff TOU-GS-3, seasonal demand charge
- electric peak load 500 kW and above: tariff TOU-8, seasonal demand charge

## ● SDGE

- The same electricity rate is used for all simulations, AL-TOU. The main difference is that fixed cost is higher for above 500kW than below.

Sources: PGE tariffs effective March 1 2009, SCE tariffs effective February 9 2009, SDGE tariffs effective January 1 2009

A-1: [http://pge.com/tariffs/tm2/pdf/ELEC\\_SCHEDS\\_A-1.pdf](http://pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_A-1.pdf)

A-10: [http://www.pge.com/tariffs/tm2/pdf/ELEC\\_SCHEDS\\_A-10.pdf](http://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_A-10.pdf)

E-19: [http://www.pge.com/tariffs/tm2/pdf/ELEC\\_SCHEDS\\_E-19.pdf](http://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_E-19.pdf)

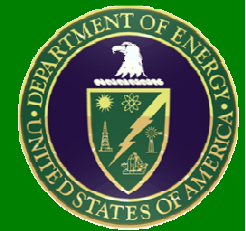
GS-2: <http://www.sce.com/NR/sc3/tm2/pdf/ce30-12.pdf>

TOU-GS-3: <http://www.sce.com/NR/sc3/tm2/pdf/CE281.pdf>

TOU-8: <http://www.sce.com/NR/sc3/tm2/pdf/ce54-12.pdf>

AL-TOU: [http://www.sdge.com/tm2/pdf/ELEC\\_ELEC-SCHEDS\\_AL-TOU.pdf](http://www.sdge.com/tm2/pdf/ELEC_ELEC-SCHEDS_AL-TOU.pdf)





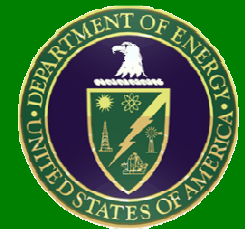
# Sensitivity Runs

18 different scenarios have been performed so far for the midsize commercial sector

- Low NG prices in 2020, spring 2009 NG prices are kept constant in real terms, SGIP of \$500/kW for FCs, **run L**
- High natural prices in 2020, maximum NG prices in 2008 are kept constant in real terms, SGIP of \$500/kW for FCs, **run H**
- Medium NG prices in 2020, average of the NG prices between January 2006 and March 2009 are constant in real terms, SGIP of \$500/kW for FCs, **run M**, **"Reference Case"**
- Medium NG prices in 2020 and higher marginal carbon emission rates during off-peak hours in southern CA, SGIP of \$500/kW for FCs, **run M-hc** (marginal CO<sub>2</sub> rate during off-peak hours of 0.7883kgCO<sub>2</sub>/kWh, Marnay, C. et al., "Estimating Carbon Dioxide Emissions Factors for the California Electric Power Sector", Lawrence Berkeley National Laboratory Report LBNL 49945, Aug.2002.)



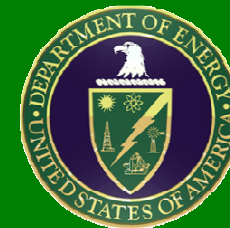
# Sensitivity Runs



- Medium NG prices in 2020 and **higher** marginal carbon emission rates during off-peak hours in southern CA and **SGIP** incentive of \$750/kW for FCs, **run M-hc-SGIP**
- Medium NG prices in 2020 and **no min.** load constraint, SGIP of \$500/kW for FCs, **run M-no-min** (for all other runs a minimum load constraint of 0.5 is imposed and the engines cannot operate with less than 50% nameplate capacity)
- Medium NG prices in 2020 and **only FCs** are allowed, SGIP of \$500/kW for FCs, **run M-onlyFC**
- Medium NG prices in 2020, **high** carbon emissions in Southern CA, **no PV** and **no solar** thermal, SGIP of \$500/kW for FCs, **run M-hc-noPVSolar**



# Sensitivity Runs

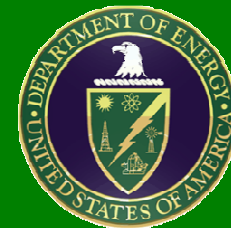


do-nothing	run L	run H	run M	run M-hc	run M-hc-SGIP	run M-no-min	run M-onlyFC	run M-hc-noPVSolar
total annual costs (M\$)	4859.7	5381.8	5030.8	5030.8	5030.8	5030.8	5030.8	5030.8
total annual CO2 emissions (Mt/a)	19.7	19.7	19.7	21.4	21.4	19.7	19.7	21.4

invest cases	run L	run H	<u>run M</u> <u>Reference</u> <u>Case</u>	run M-hc	run M-hc-SGIP	run M-no-min	run M-onlyFC	run M-hc-noPVSolar
total annual costs (M\$)	4103.6	5257.0	4837.9	4837.9	4836.1	4838.7	4921.1	4857.6
total annual CO2 emissions (Mt/a)	18.5	18.7	18.4	19.7	19.7	18.4	18.5	20.0
total installed capacities (without PV) (GW)	4.7	0.1	1.5	1.5	1.5	1.6	0.7	1.5
total electricity produced by DG (without PV) (TWh)	24.1	0.4	7.4	7.4	7.4	7.4	3.7	7.4
total cooling offset (TWh)	2.2	0.0	0.4	0.4	0.4	0.4	0.0	0.4
changed costs compared to do-nothing (%)	-15.6	-2.3	-3.8	-3.8	-3.9	-3.8	-2.2	-3.4
changed CO2 compared to do-nothing (%)	-6.2	-4.9	-6.7	-8.0	-8.0	-6.7	-6.1	-6.4
average capacity factor DG (without PV) (%)	58.8	55.5	54.9	54.9	55.0	53.0	63.6	57.9



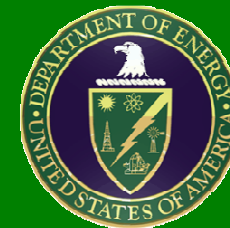
# Sensitivity Runs



- Medium NG prices in 2020 and a **4%** interest rate, SGIP of \$500/kW for FCs, **run M-4%i**
- Six different carbon tax runs with and without PV / solar thermal as possible option, SGIP of \$500/kW for FCs
  - \$150/tC ( = \$40.1/tCO<sub>2</sub>), **run M-lowCtax; run M-lowCtax-noPVSolar**
  - \$450/tC ( = \$122.7/tCO<sub>2</sub>), **run M-medCtax; run M-medCtax-noPVSolar**
  - \$1000/tC ( = \$272.7/tCO<sub>2</sub>), **run M-highCtax; run M-highCtax-noPVSolar**
- Medium NG prices in 2020 and a **Feed-in Tariff** which reflects the whole purchase tariff, the feed-in tariff applies to all DG technologies, no SGIP, **run M-FiT** (constraint: purchase > sales; this constraint is needed otherwise some sites would install CHP without limits. This can drive the energy conversion efficiency near the macrogrid efficiency of ca. 34% since most of the waste heat could not be utilized)



# Sensitivity Runs

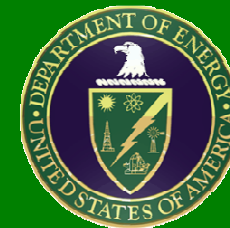


- Medium NG prices in 2020 and a **Feed-in Tariff** which reflects the whole purchase tariff, the feed-in tariff applies to all CHP technologies, **no PV** and **no solar**, no SGIP, **run M-FiTnoPVSolar** (constraint: purchase > sales)
- Medium NG prices in 2020 and a high SGIP incentive of \$1500/kW (=60% of the 2008 incentive value) for FCs and a 60% annual efficiency constraint for FCs using SGIP, **run M-SGIP60%**
- Medium NG prices in 2020 and a **Feed-in Tariff** which reflects the **generation** component of the tariff, the feed-in tariff applies to all DG technologies, no SGIP, **run M-FiTg**
- Medium NG prices in 2020 and a **Feed-in Tariff** using the MPR and TOD, **run M-MPR**, some technical problems / issues needs to be resolved

in all runs electricity tariffs (for purchase) from early 2009 / late 2008 are used and constant in real terms



# Sensitivity Runs

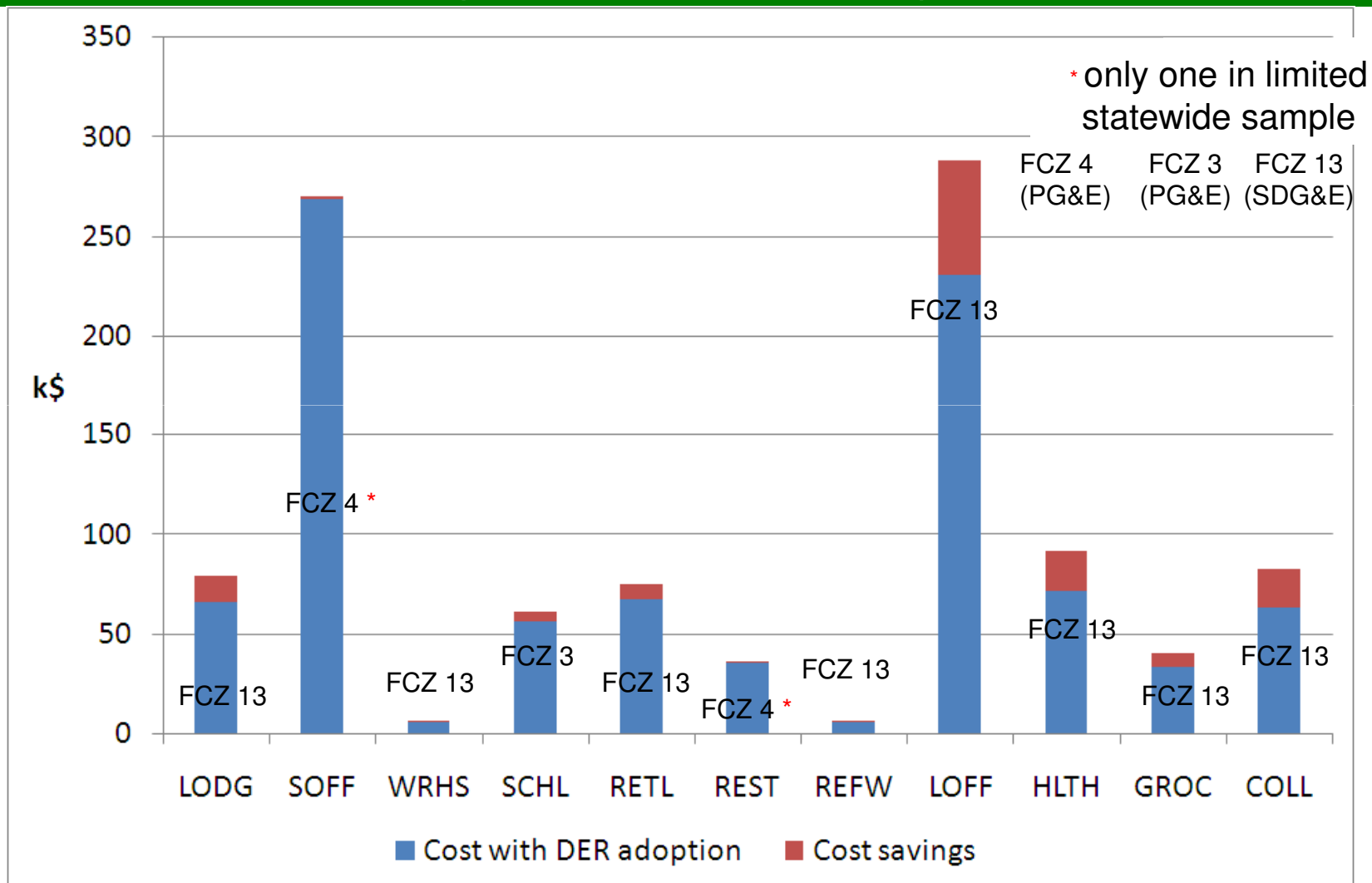
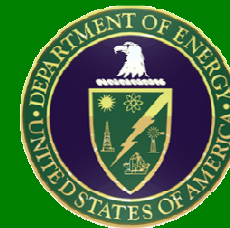


do-nothing	run M-4%i	run M-lowCtax	run M-lowCtax - noPVSolar	run M-medCtax	run M-medCtax - noPVSolar	run M-highCtax	run M-highCtax - noPVSolar	run M-FiT	run M-FiT noPVSolar	run M-SGIP60%
total annual costs (M\$)	5030.8	5837.4	5837.4	7449.0	7449.0	10408.1	10408.1	5030.8	5030.8	5030.8
total annual CO2 emissions (Mt/a)	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7

invest cases	run M-4%i	run M-lowCtax	run M-lowCtax - noPVSolar	run M-medCtax	run M-medCtax - noPVSolar	run M-highCtax	run M-highCtax - noPVSolar	run M-FiT	run M-FiT noPVSolar	run M-SGIP60%
total annual costs (M\$)	4757.0	5574.5	5624.5	6885.8	7147.2	9068.2	9934.4	4828.0	4848.9	4706.9
total annual CO2 emissions (Mt/a)	17.5	17.8	18.7	15.2	18.6	13.9	18.0	18.2	18.7	17.9
total installed capacities (without PV) (GW)	1.4	1.4	1.5	1.5	1.7	1.5	2.2	1.5	1.6	2.9
total electricity produced by DG (without PV) (TWh)	7.4	7.3	7.5	6.4	8.1	7.0	10.7	7.5	8.0	10.3
total cooling offset (TWh) :	0.4	0.4	0.4	0.2	0.4	0.1	0.2	0.4	0.5	0.6
changed costs compared to do-nothing (%)	-5.4	-4.5	-3.6	-7.6	-4.1	-12.9	-4.6	-4.0	-3.6	-6.4
changed CO2 compared to do-nothing (%)	-10.9	-9.9	-5.2	-22.9	-5.6	-29.2	-8.5	-7.8	-5.1	-9.3

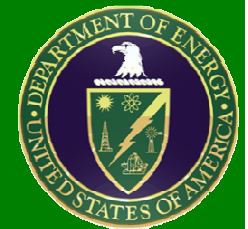


# Cost Savings – Best Bldgs. (Reference Case)

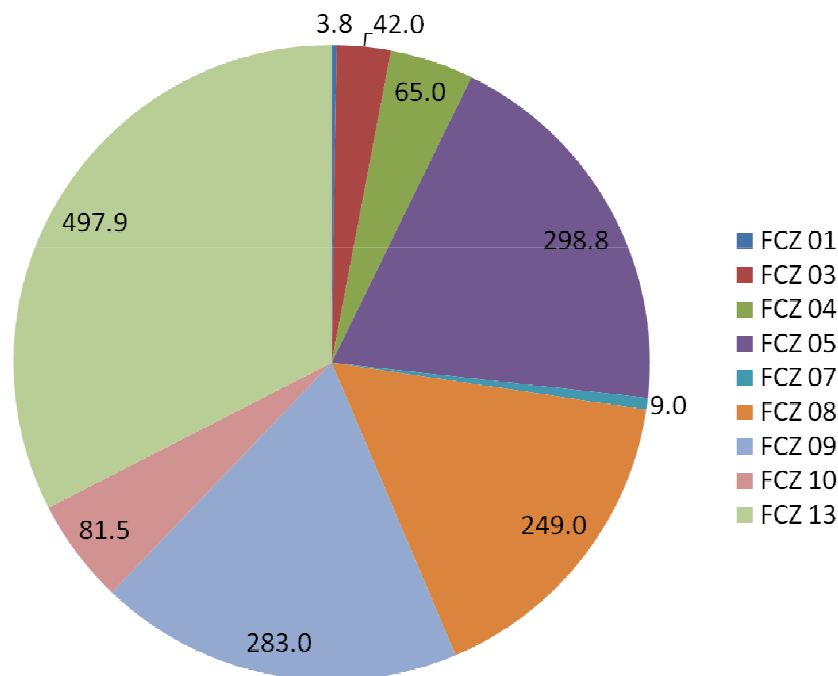




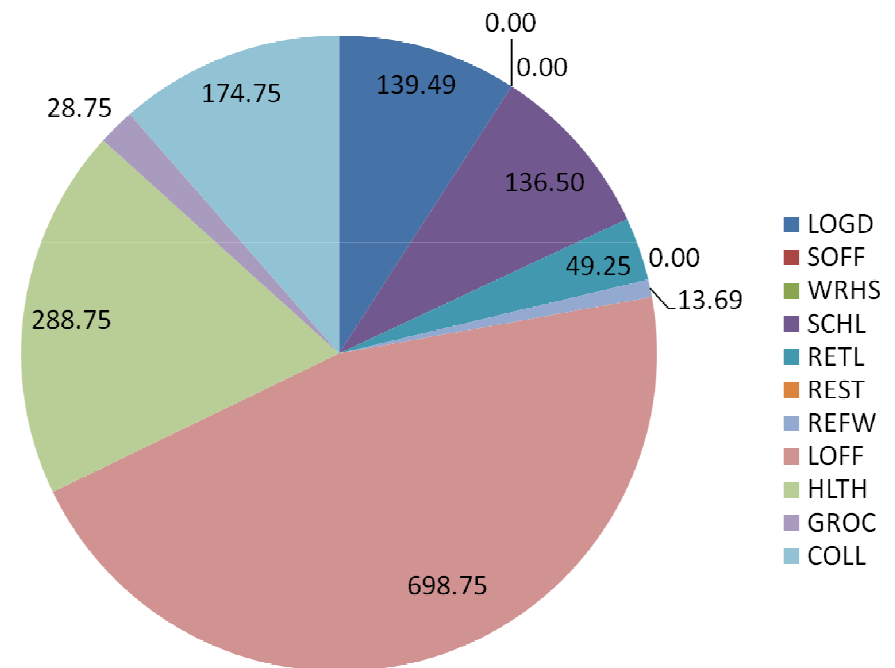
# Installed Capacity (MW) (Reference Case)



By Climate Zone



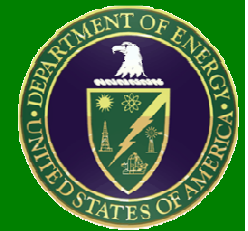
By Building Type



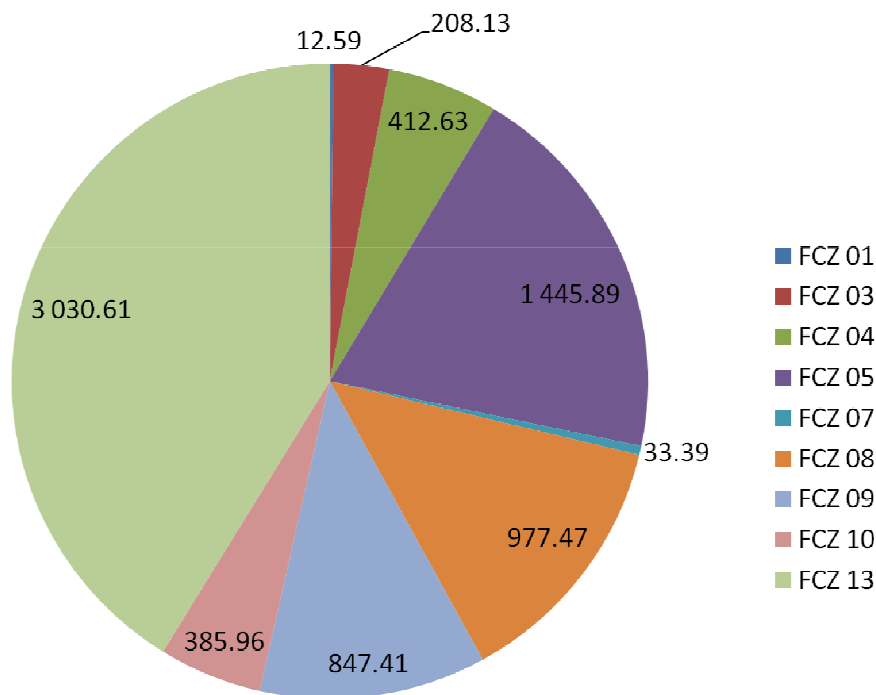
Total installed capacity in limited statewide = 1.5 GW



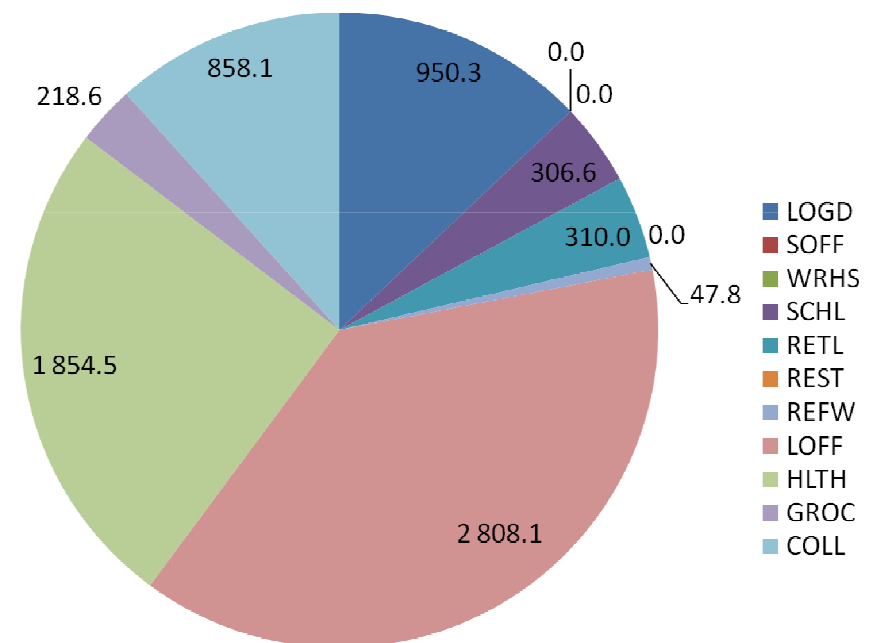
# On Site Generation (GWh/a) (Reference Case)



By climate zone



By building type



Total on site generation in limited statewide = 7.4 TWh